



# **TRMM and GPM International Science Conference**

**Tokyo Japan**

**November 13-16, 2012**

***Enhancing TRMM with a Near-realtime System  
and Special Products***

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# Special Dedication for the 15<sup>th</sup> Anniversary



**Dr. Joanne Simpson**

**Dr. Tsuyoshi Nitta**



# Stocker's Special Thanks for TRMM Excellence



- Dr. John Theon NASA/Hq TRMM Program Scientist
- Dr. Ramesh Kakar NASA/Hq Current TRMM Program Scientist
- Dr. Nobuyashi Fugono – CRL
- Mr. Thomas LaVigna NASA GSFC TRMM Project Manager
- Mr. Thomas Keating NASA GSFC TRMM System Engineer (*special thanks for the nice large fuel tank*) – who died very recently
- Dr. Otto Thiele- NASA/GSFC
- Dr. Ken'ichi Okamoto CRL - for leading a well oiled international PR science team and fantastic original CRL PR design team

**Of course many others, both in U.S. and Japan, should be mentioned but time does not allow**



# Realtime Background



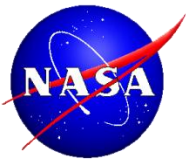
- **Beginning several years before launch many attempts were made by the TRMM project to incorporate a “near-realtime” component into the TRMM requirements**
- **Management forbade altogether that any mention of “realtime” be used in conjunction with TRMM**
- **Cost estimates for implementing “realtime” requirements at the project/satellite-instrument level were very high**
- **So, prior to launch no permission was given to implement “realtime” requirements for the mission instead these were expressly prohibited.**
- **However, TRMM did have the capability of providing 3 quicklook downloads each day and at times up to 4 per day.**
- **Even after launch requests continued from operational agencies to get TRMM “realtime” data (particularly from JMA and NRL)**



# NASA TRMM Project Scientist Waved his Magic Wand



- **In 1999, the then Project Scientist, Dr. Christian Kummerow (now of CSU fame) came to PPS (then TSDIS) to explore possibilities of implementing a low-cost “near-realtime” (NRT) system**
  - There were to be no REQUIREMENTS for the products
  - The goal was to have the swath precipitation retrievals available to the users within 120 minutes 90% of the time.
- **NRT objectives suggested by Dr. Kummerow:**
  - Minimum to no additional cost and NO impact on the standard TRMM operation
  - Because of network bandwidths at the time, keep the NRT products around 7MB to facilitate retrievals
  - Avoid having to prepare separate algorithms for NRT but tie the NRT algorithms to the JTST controlled TRMM standard products
  - Implement as quickly as possible
  - Provide swath based NRT products from both TMI and PR
  - Make the NRT products as simple as possible for easy use



# NRT Swath Products



- **Implementation**

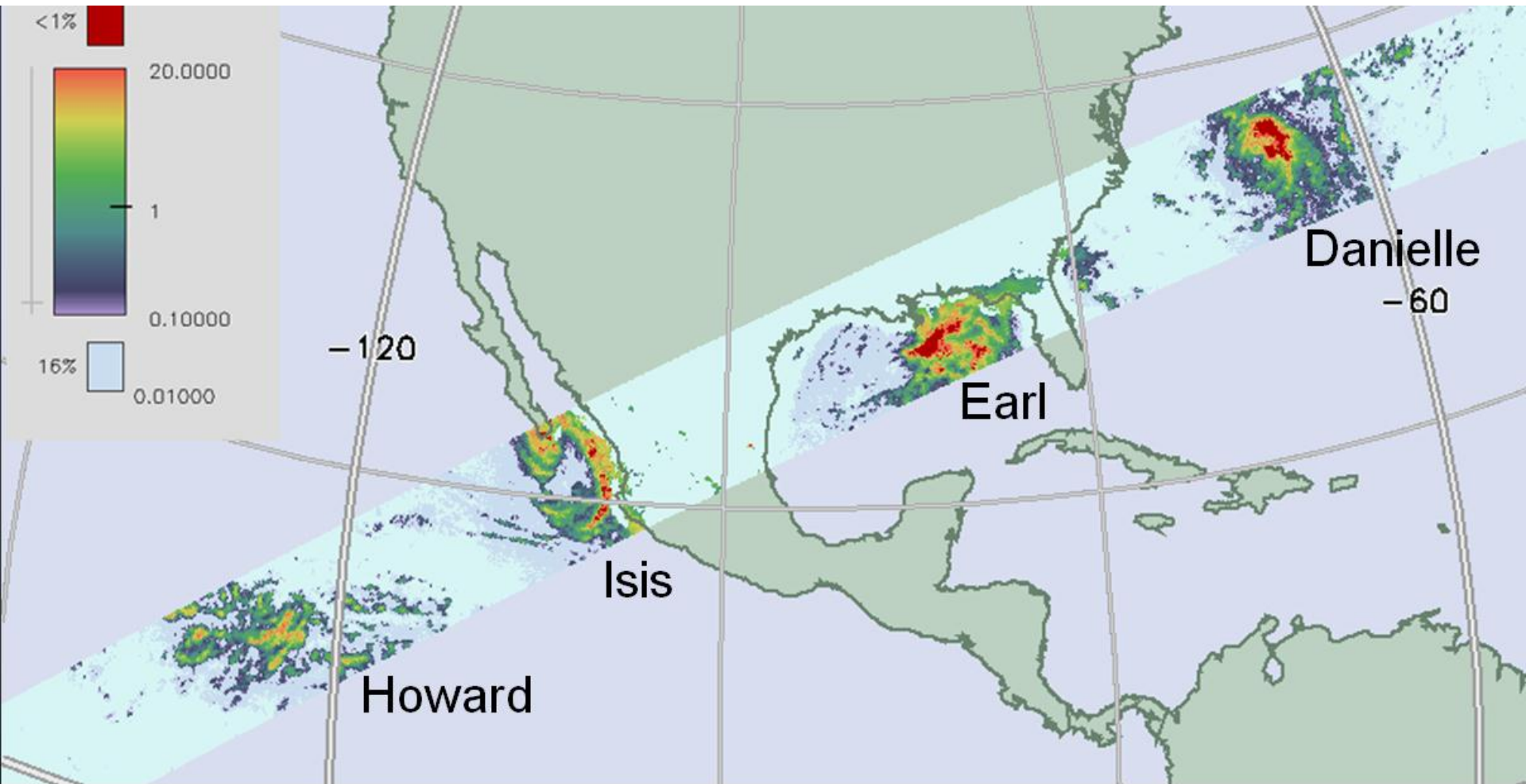
- Generate the full products (so only JTST approved algorithm code used)
- Parameter subset the full products to the target size
- Distribute the parameter subsetted products

- **Products**

- VIRS L1B radiances
- TMI L1B Brightness Temperature
- TMI L2 GPROF rain retrievals
- PR L2 Rain classification
- PR L2 Estimated surface rain/near surface reflectivity
- PR L2 20-level Vertical profile of rain/reflectivity



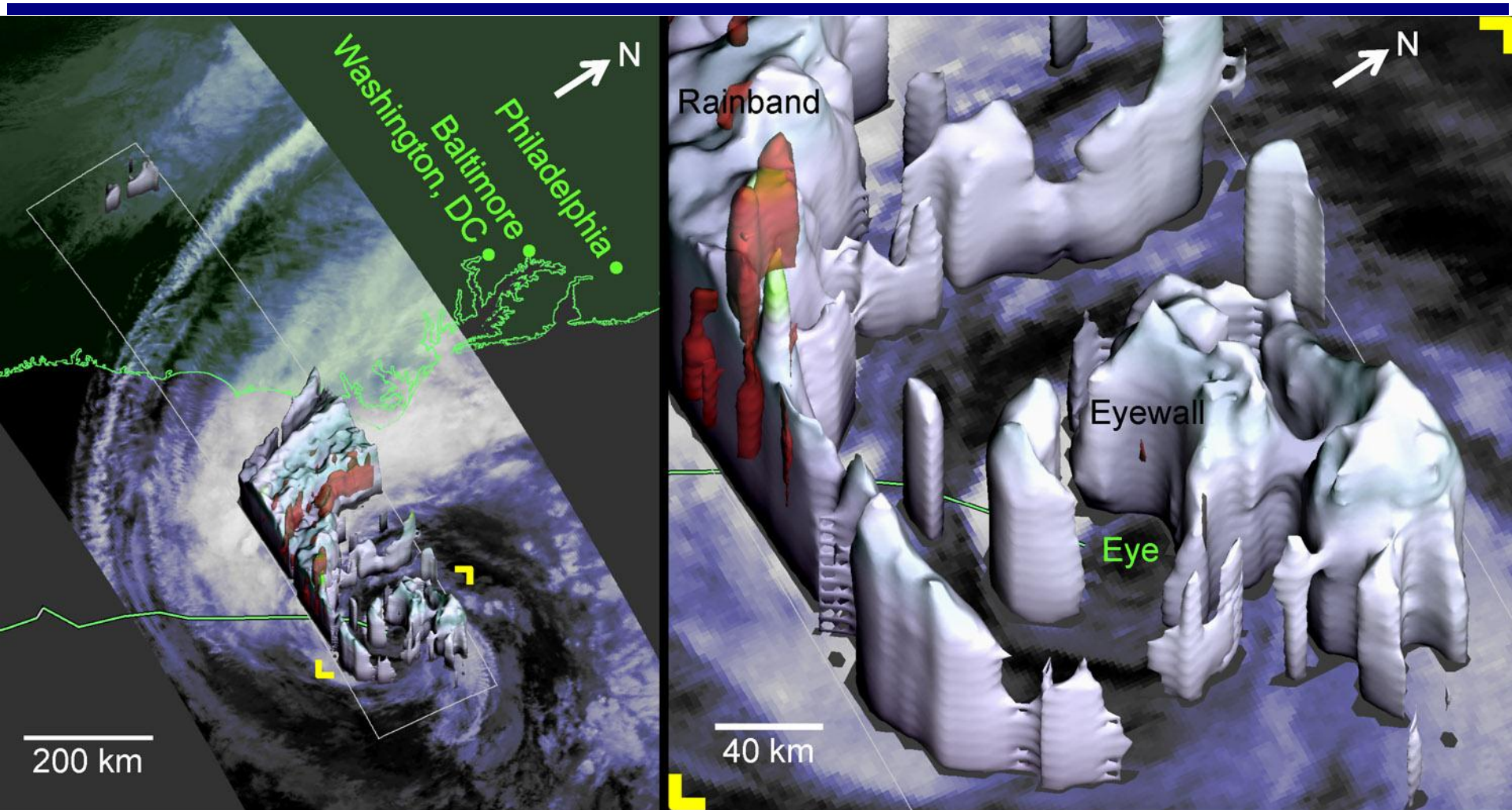
# Four Storms Line Up for TMI in Sep 1998







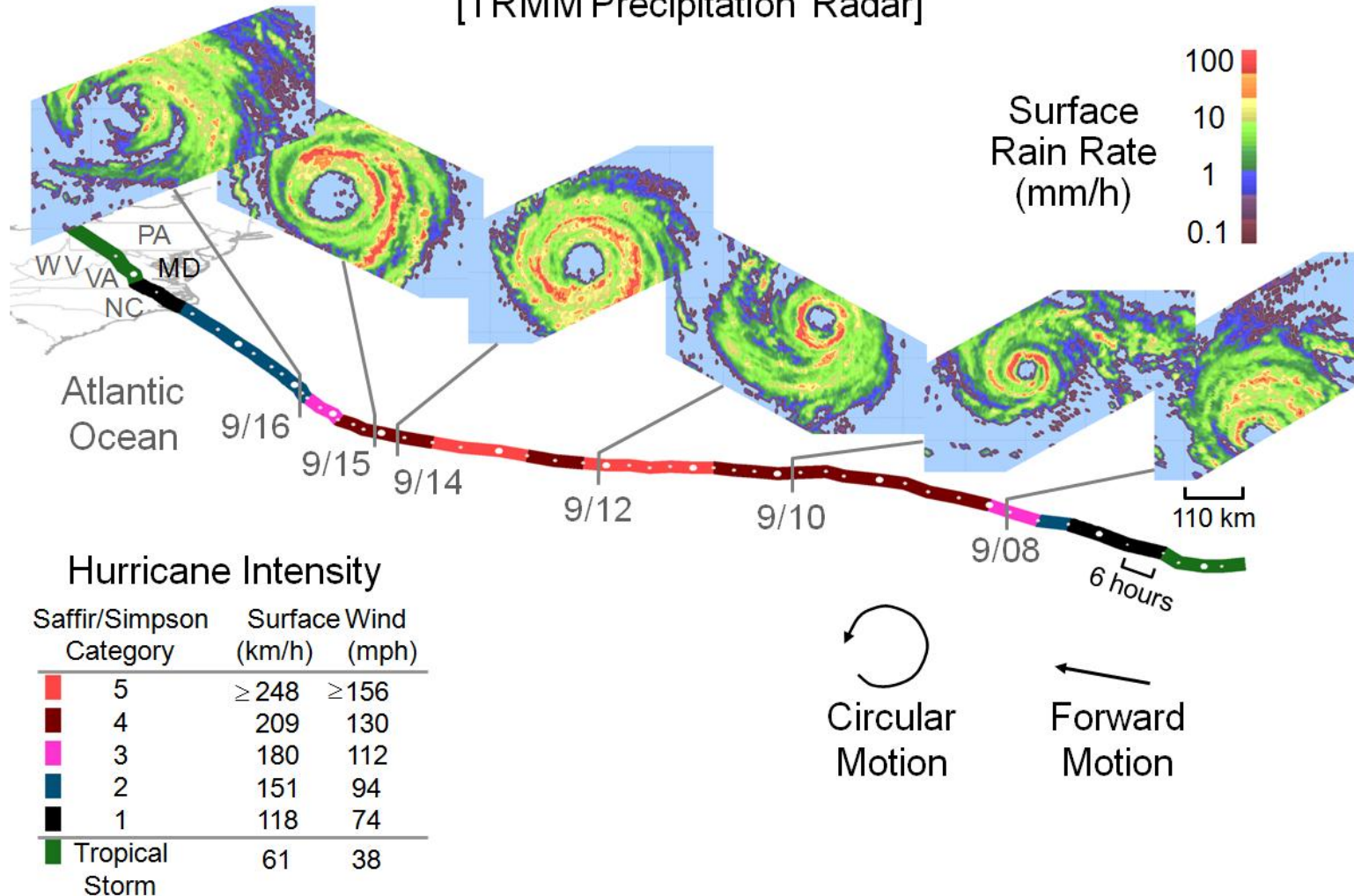
# PR Captures Hurricane Sandy (2012)



Hurricane Sandy observed by the TRMM Precipitation Radar at 2:20 EDT on 28 October 2012

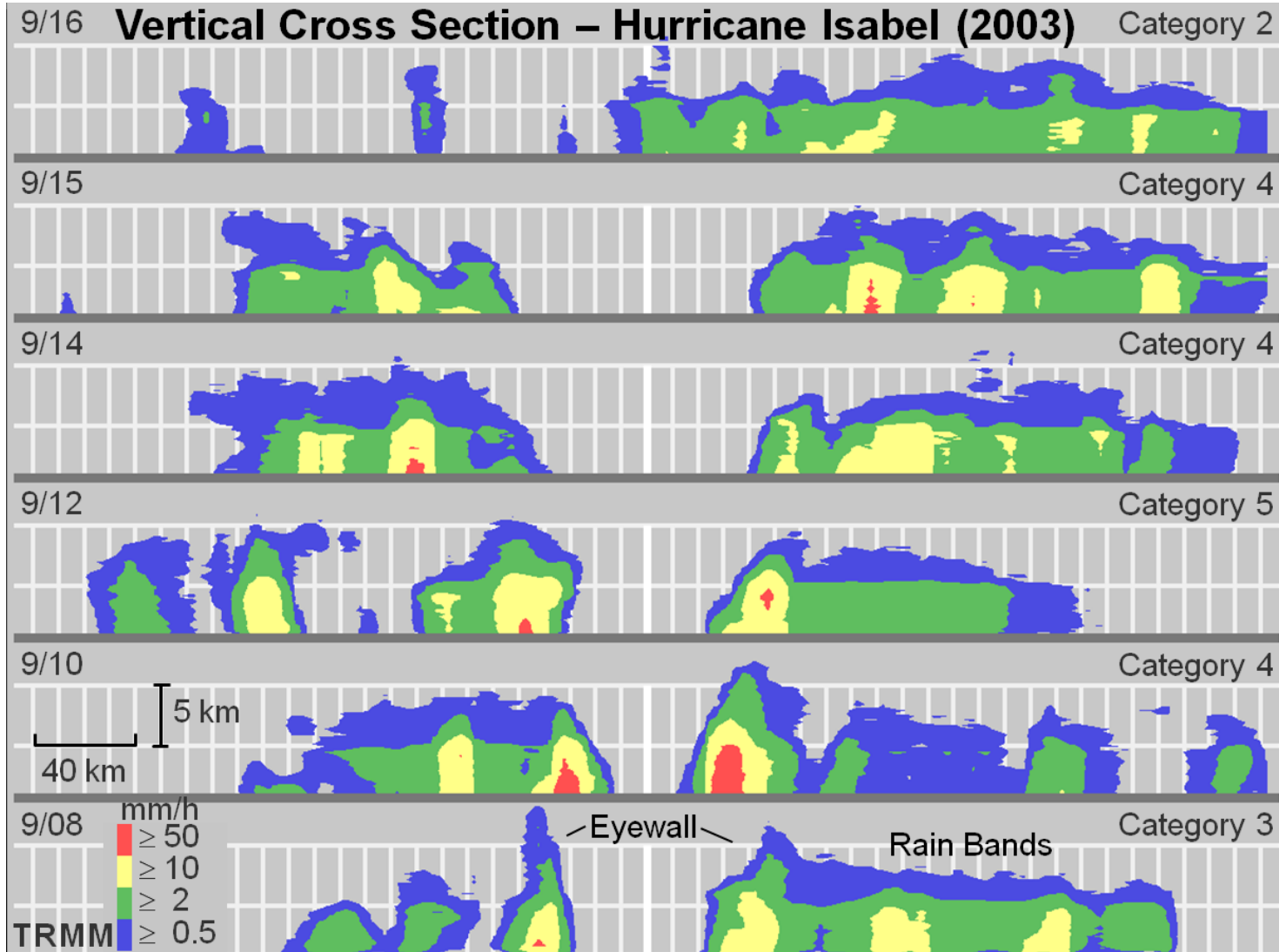


## Horizontal View of Hurricane Isabel in September, 2003 [TRMM Precipitation Radar]





# PR Vertical Cross Section for Isabel-2003





# More Kummerow Magic-Special Products



- **In 1999, Dr. Kummerow developed the concept of files that contained retrieval information**
  - for the three key “instruments” (TMI, PR, combined)
  - were to be in text, line driven and easily accessible even via spreadsheets.
- **From this objective were developed the 3G family of products (these not realtime)**
  - 3G01 Hourly gridded .5 deg x .5 deg VIRS Tb packaged into daily files (one for channel 4 and a separate one for channel 5)
  - 3G68 Hourly gridded .5 deg x .5 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
  - 3G68 quarter degree hourly gridded .25 deg x .25 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
  - 3G68Land Hourly gridded .1 deg x .1 deg TMI, PR, Combined retrievals packaged into daily files: (total pixels, rainy pixels, unconditioned mean, percent convective)
    - Africa
    - South America
    - Australia (at request of a Japanese investigator)



## Sample of 3G68 file



4G68Quarter 2.1 NONE NONE NASA/JAXA/NICT 2012-11-01T15:24UTC

720 1440 -90 -180 0.25 20121028

-40 40 -180 180

Grid\_First\_Row=0 Grid\_Center\_Latitude=-89.875 Grid\_First\_Column=0

Grid\_Center\_Longitude=-179.875 Grid\_Cell\_Resolution=0.25

Duration=Day

hour minute row column TMI\_total\_pixels TMI\_rain\_pixels TMI\_mean\_mm/hr

TMI\_%convective PR\_total\_pixels PR\_rain\_pixels PR\_mean\_mm/hr

PR\_%convective TCI\_total\_pixels TCI\_rain\_pixels TCI\_mean\_mm/hr

TCI\_%convective

0 24 203 692 3 0 0.0000 0 0

0 24 203 693 3 0 0.0000 0 0

18 13 499 447 11 11 19.7037 55 0

18 13 499 448 12 12 20.3272 43 0

18 13 499 449 12 12 19.7004 63 0

18 13 499 450 14 14 15.2794 53 0

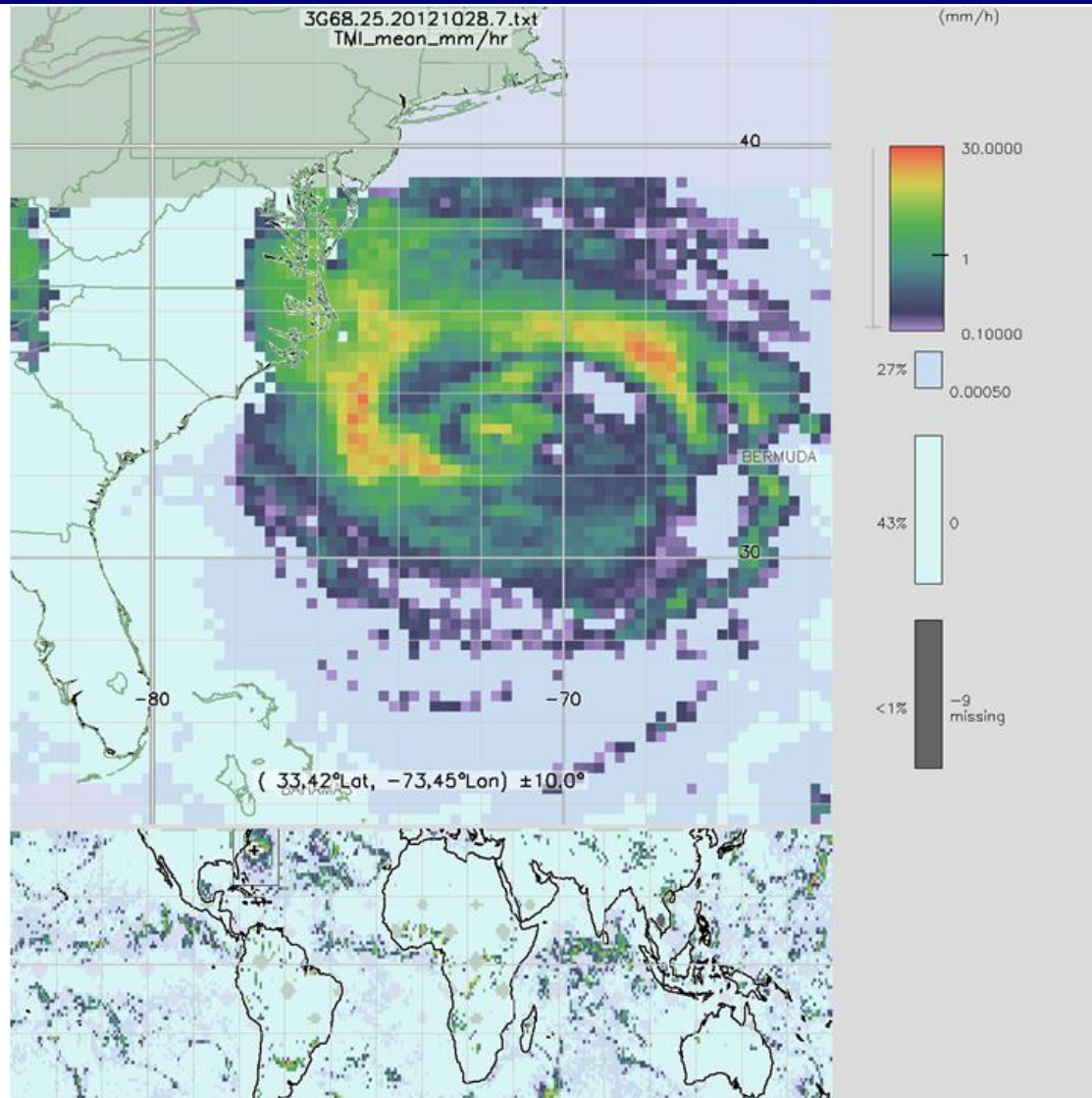
18 9 502 387 10 4 0.5315 0 27 9 0.5863 35 27 9 0.4929 23

18 9 502 388 8 5 1.0687 0 23 12 0.7991 23 23 12 0.7089 14

18 9 502 389 11 0 0.0000 0 22 8 0.3653 0 22 8 0.3812 0



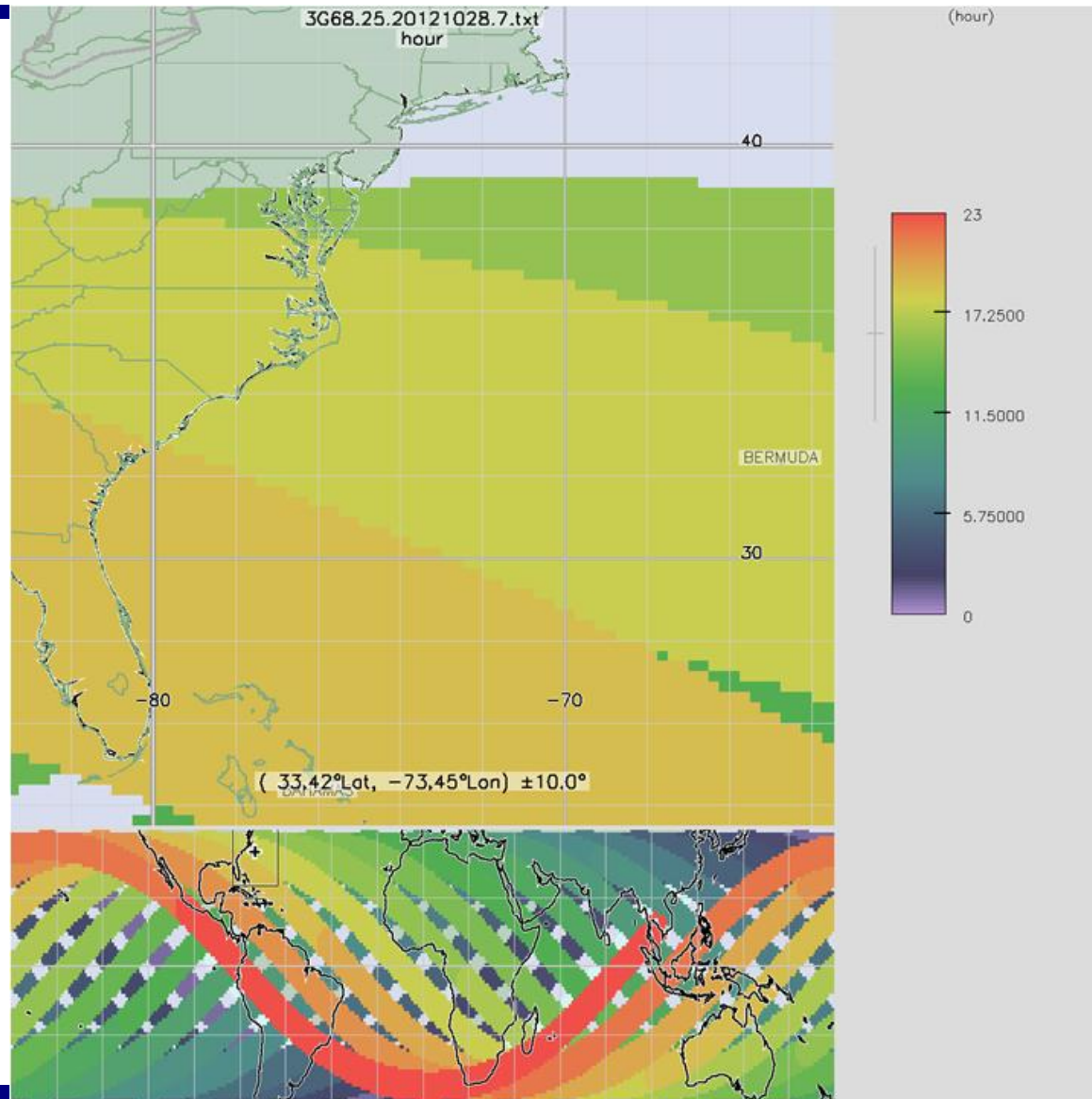
# Hurricane Sandy (2012) in 3G68-25

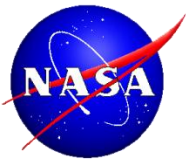






# Example of 3G68 Daily File





# Why have we been up for 15 years



- **We have 15 years because of Dr. Robert Adler who became the TRMM Project Scientist in 2000 when Dr. Kummerow left for academia**
- **Dr. Adler advocated, coordinated and insured the carrying out the boost in August 2001**
  - Obtained TRMM science team buy-in to the boost
  - Coordinated with Japanese colleagues to get the buy-in by JAXA
  - Close coordination with Dr. Okamoto and the PR team who did the analysis and the work to ensure the PR continued to give useful precipitation data even at the new altitude
  - Coordinated with NASA Hq to get the approval to boost the orbit.
  - Coordinated and guided the Flight Operations Team (FOT) activities for the boost maneuver (FOT did a remarkable job )
- **2004 Dr. Adler puts his career on the line to keep TRMM in orbit**
  - In 2004 NASA/Hq Dr. Asrar decided that TRMM's usefulness to research had been carried out and the satellite should be brought down. JAXA agreed.
  - Dr. Adler worked tenaciously and often against the advice of his managers to ensure that TRMM stayed in orbit.
  - He prepared the documentation to obtain an exception to the controlled re-entry requirement from NASA Hq
  - TRMM science team members helped get congressional support



# Another Adler gift



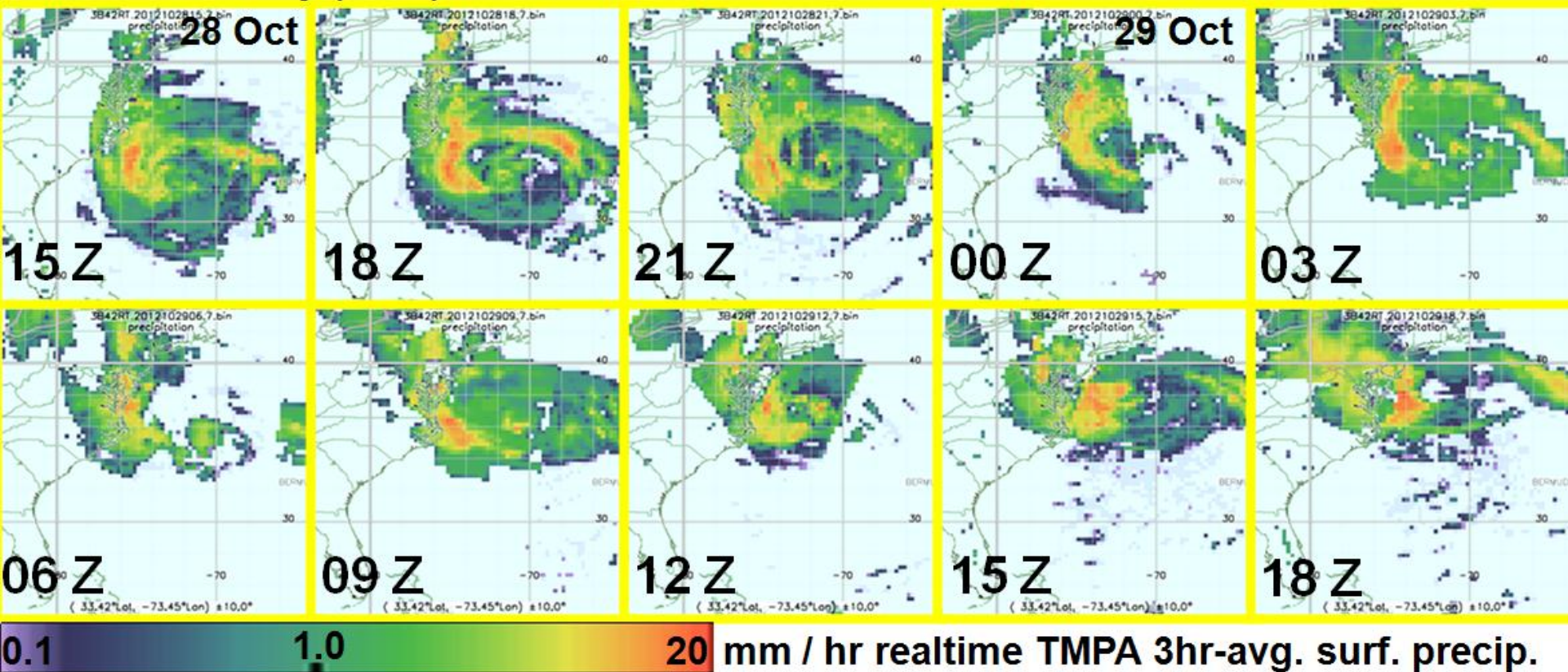
- **In 2001 while project scientist Dr. Adler asked that PPS set up a realtime version of the TRMM Multi-satellite Precipitation Analysis (TMPA)**
  - Merged radiometer data only 3B40rt
  - “calibrated “ IR 3B41rt
  - Merged IR and radiometer product 3B42rt
- **Products to be**
  - .25 x .25 degree “global”
  - 3 hour time resolution
  - Binary format
- **Latency objective: ~6 hours after data collection**
- **NRT TMPA uses when available**
  - TMI
  - CPC 1 hourly 4km IR
  - SSMI/SSMIS (F13, F14, F15, F16,F17, F18)
  - AMSUB and MHS
  - AMSRE



# 3Hr Sequence-3B42rt Sandy Images



## Hurricane Sandy (2012)







# Another Special Product-Univ of Utah



- **PPS and University of Utah started working jointly to run the University of Utah Precipitation Features (PF) algorithm at PPS. Initial coordination initiated by Dr. Ed Zipser (TAMU and now University of Utah)**
  - Started working with Dr. Steve Nesbitt on the core L1 and L2 products
  - Worked with Dr. Daniel Cecil (now at GHRC) to add LIS information to PF
  - Currently working with Dr. Chuntao Liu to extend and include latent heating
- **Products produced at PPS NASA/GSFC but supported and distributed by University of Utah**
- **PPS helped with funding to set up a PF website at UU to facilitate widespread use of TRMM PF**

**[trmm.chpc.utah.edu](http://trmm.chpc.utah.edu)**





# Sample of MCS Search-UU website



University of Utah PMM Science - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Inbox - erichstocker@gmail.c... Google Calendar (1 unread) - erichstocker - Ya... Hotmail - erichstocker@hotmail... tmapa - Google Search University of Utah PMM Science TMAPA

Bookmarks

Search:

Bookmarks Toolbar

Bookmarks Menu

Recent Tags

Recently Bookma...

Recently Bookma...

Recent Tags

Bookmarks Tool...

Business and Fin...

Entertainment an...

News and Sports

Personal Toolbar ...

Quick Searches

Search

Search and Direc...

Netscape Sear...

Alta Vista

Ask Jeeves

Google

GoTo

HotBot

LookSmart

Lycos

Shopping and Cla...

Travel and Leisure

Directories

Firefox and Mozill...

Google

MapQuest: Home

WebCrawler

International Cou...

Google Mail

Welcome to Yah...

Hotmail - The Wo...

Netscape Mail

NOMAD Mail

Precipitation Proc...

Anne Arundel Co...

Free Translation ...

Documentation I...

NASA Federal Cr...

Pentagon Federal...

PayPal

eBay Listings

Yahoo!

weather.com - In...

Python Documen...

PPS Internal

Workstation update

GSFC Internal Ho...

WebTads

The P-Card Web ...

Saturn

Employee Expres...

Identity Manager

Radiometer Level...

ODN

GSFC Grants Ho...

NSSC Customer ...

A Q U A R I U S

Earth Science Ent...

NASA Homepage

Earth Science Ma...

AMS Glossary

SEMS - SESDA-II ...

University of Utah PMM Science

Precipitation Top 100 Storms Climatology Tropical Cyclones Other

Google Tool

Heavy Rainfall

Thunderstorms

Tower Clouds

MCSs

Publications

Data download

Related Links

TRMM

GPM

JAXA

PPS

TSIS

Rainfall Data Links

TRMM data

Real time 3B42

GPCP

GPCC

This project is supported by NASA Grant NNX08AK28G under PPS

26803 2002-7-28 15:22-UTC

PR near surface reflectivity (dBZ)

Mesoscale Convective Systems (MCSs)

A mesoscale convective system (MCS) is a precipitation system that becomes organized on a distinctly larger spatial and temporal than its constituent convective clouds, and normally persists for several hours or more. MCSs may be round or linear in shape as the example shown, and include systems such as squall lines, Mesoscale Convective Complexes (MCCs), parts of monsoon depressions or tropical cyclones, among others, and a wide variety of midlatitude weather events. They have been noted across North America and Europe, with a maximum in frequency during the late afternoon and evening hours during the warm season (i.e. late spring and summer) on both continents, but often reach their maximum extent during the night. Over much of the world, MCSs bring about half the annual rainfall.

Here we define an MCS as a system with contiguous precipitating area greater than 2000 km<sup>2</sup> from TRMM observations. During the past 14 years (1998-2011), there are about 1.2 million MCSs in the TRMM database. Information regarding these MCSs can be accessed through the search engine below.

Search TRMM MCSs in 1998-2011

Date: From 20030401 to 20030401 (YYYYMMDD)

Latitude: From -40 to 40 degree

Longitude: From -180 to 180 degree

Volumetric Rain: From 0 to 4000000 (mm/hour\*km<sup>2</sup>)

greater than 0 km

less than 250 K and greater than -999 K

Flashes: at least -100 #

MaxNearSurfDBZ: greater than 0 dB

%convective: greater than 0 %

Land or Ocean: Both

Sort by: date

Submit Reset

Meaning of Parameters

- Volumetric Rain: Integrated rain volume over the entire raining area in the precipitation system.
- MaxHt 20 dBZ: Maximum height with 20 dBZ PR reflectivity within the precipitation system.
- Min85GHzPCT: Minimum Polarization Corrected Temperature at 85 GHz observed by TMI within the precipitation system.
- MaxNearSurfDBZ: Maximum near surface reflectivity.
- %convective: Percentage of rainfall from the convective region of the precipitation system as determined from the 2A23 algorithm.

Why there are invalid values in some parameters?

There are many cases when TMI, VIRS or LIS do not return valid values due to the instrument calibration or some other reason. When that happens, we do not throw all the data away, because other instruments may be working OK. So we mark -999 for the corresponding parameters for these cases.

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# Acknowledgement



**Very special thanks to Dr. Owen Kelley who  
generated the images**